PHYSIOLOGICAL AROUSAL AND CURSING: SUPPORT FOR A FEEDBACK MODEL OF NEUROGENIC CURSING

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by
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ABSTRACT

Many neurological disorders are characterized by uncontrolled or non-volitional cursing. The social stigma of coprophenomena can be immense, particularly for young adults with traumatic brain injury or Tourette Syndrome. Little is known about the neurocognitive mechanisms underlying non-volitional cursing, and there is no known treatment. To this end, I propose a mechanism that will prove useful as a guiding theoretical framework for modeling different types of cursing. My overarching hypothesis is that uncontrolled cursing is the breakdown of a feedback loop between physiological arousal and controlled language output. I operationalize the hypothesis that cursing occurs in the context of physiological arousal and the act of cursing further modulates arousal. This thesis will illustrate how the model predicts different patterns of impairment across different disorders of emotion and behavior dysregulation. I will test predictions of the model in two experiments both involving manipulations of arousal and linguistic content. In Experiment 1, I compare the arousal of the lexical environment of curse words to the that of randomly selected non-curse words in a large natural language corpus. In Experiment 2, I use a verbal fluency paradigm to compare physiological arousal and subsequent language production during a cursing task vs. a non-cursing task.

ACKNOWLEDGMENTS

"Frankly, my dear, I don't give a damn."

The most famous movie line of all time nearly wasn't, due to the 1930 Motion Picture Production Code prohibiting curse words in film scripts (American Film Institute, n.d.). Only a last-minute amendment to the Code allowed the line to remain uncensored. "Frankly, my dear, I don't give a darn" certainly doesn't pack the same punch, but why not? What does *damn* do that other words fail to convey? I still don't fucking know, but it certainly has been fun trying to unpack some of this over the past couple years.

Jamie, I cannot thank you enough for your mentorship and friendship, for supporting and encouraging me as I navigated both the clinical and research parts of graduate school, and for making me feel like I belonged here doing this work.

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CHAPTER 1. INTRODUCTION

Cursing is a common outlet for expressing intense emotion. Social and cultural norms dictate when and where it is appropriate to curse. Our ability to behave within these constraints relies on numerous cognitive capacities including theory of mind and executive functions. Neurological disorders, particularly those affecting the frontal lobes, often compromise one or more of these cognitive capacities (Alvarez & Emory, 2006). People with neurological disorders including stroke aphasia, behavioral variant frontotemporal dementia, Tourette's syndrome, and traumatic brain injury often curse excessively or without meaning to (Van Lancker & Cummings, 1999). Uncontrolled cursing, also known as neurogenic cursing or coprolalia, often has serious social and emotional consequences for both patients and caregivers (Le Dorze & Brassard, 1995; Eddy & Cavanna, 2013) There are currently no established efficacious behavioral treatments for neurogenic cursing.

The overarching aim of this thesis is to further our understanding of cursing and to explore a novel mechanism for prediction and feedback control of cursing as modulated by physiological arousal. Objectives are as follows:

1. I will summarize the current state of research on relation(s) between non-volitional cursing and dysregulated control processes.
2. I will propose an integrative feedback model of cursing and physiological arousal.

3. I will propose two experiments investigating relations between physiological arousal and cursing.
4. I will interpret the empirical findings, identify limitations, and highlight directions for future work needed to refine and support (or refute) the model.

Cursing

Cursing, a near-ubiquitous phenomenon across natural languages, is the production of a word or phrase deemed taboo or offensive in a particular culture or context. "Tabooness" is often conceptualized as the intersection of high arousal and negative valence (Janschewitz, 2008; Jay, 2000), though this does not fully explain the power behind curse words: there many words that have high lexical arousal and high negative valence that are not taboo (*cancer*, *abortion*), and there are curse words that are neither particularly lexically arousing nor particularly negatively valent (e.g., *damn;* Reilly et al., 2020). Whether you call it tabooness, profanity, or obscenity, it can be notoriously difficult to define: in 1964, when Supreme Court Justice Potter Stewart was asked to explain his test for obscenity, he simply wrote, "I know it when I see it" (Jacobellis vs. Ohio, 1964).

From a language production standpoint, it has been argued that cursing assumes two dissociable forms, first described by John Hughlings-Jackson nearly 150 years ago (Hughlings-Jackson, 1878). In non-propositional cursing, curse words function as an expletive or interjection (e.g., yelling "Shit!" when you get a paper cut). Non-propositional cursing is typically preserved, along with other forms of automatic speech (e.g., reciting the days of the week or the Lord's Prayer) in patients with left hemisphere

perisylvian strokes (Broca, 1863; Hughlings-Jackson, 1878). Thus, non-propositional language, including non-propositional cursing, is thought to be mediated by the right cerebral hemisphere.

In contrast, in propositional cursing, curse words are semantically meaningful and syntactically well-formed. As such, propositional curse words are embedded in phrases (e.g., "That shithead just stole my parking space"). Propositional cursing can be used to add emphasis, intensity, or idiomatic flavor to utterances (e.g., "This assignment is a huge pain in the ass") as well as to convey strong emotion. We curse both when we are elated ("Fuck yes!") but also when we have the intention to hurt another person ("Fuck you!").

Historically, cursing has primarily been considered an expression of anger, hatred, or aggression, and has been associated with low socioeconomic class and lack of education (Jay, 2000). Cursing can be used to harm or degrade others, as with slurs or other forms of hate speech (McWhorter, 2021). As such, it can have social costs – one study found that among women with chronic illness, those who tended to curse around other people reported decreased social support and more depressive symptoms (Robbins et al., 2011).Cursing can also incur criminal penalties: – in 2010, Pennsylvania state troopers issued more than 700 disorderly conduct citations to drivers for cursing (Peralta, 2011). Cursing, however, need not always be negative; we often curse when there is no intention to express anger or to harm another person. For example, many of us curse when surprised (e.g., "Are you fucking kidding?!") or when feeling especially ebullient (e.g., "Yes! We fucking did it!"). It is also commonly used as an intensifier (e.g., "That sandwich was tasty as hell!"), and as an expression of sexual excitement (i.e., 'dirty talk'

between sexual partners) (Jay, 2000; Jonason et al., 2016). Cursing may also confer benefits to the speaker – it has been shown to facilitate social bonding, increase grip strength and pain tolerance, and be cathartic in stressful driving situations (Baruch & Jenkins, 2007; Popuşoi et al., 2018; Stephens, 2018; Stephens et al., 2009).

In addition to its multiplicity of uses across a variety of emotional states, cursing is context-dependent both within and across cultures (Vingerhoets et al., 2013). "Cunt" in working-class Australia and New Zealand is used freely as a generic noun meaning "person" or "thing," similar to "jawn" in the Philadelphia dialect (Cain, Sian, 2023; McLeod, 2011). Use of the word 'cunt' would be unlikely to raise eyebrows in an Australian pub, but uttering 'cunt' in an American bar would likely result in a range of negative consequences. Similarly, one might refer to breasts as "tits" in the bedroom or locker room but would likely refrain from doing so in the boardroom. In general, people tend to curse more when with members of an in-group (coworkers, sports teammates) and people of their own age, social status, and gender (Jay & Janschewitz, 2008).

These examples highlight a diverse range of motives and affective states, both positive and negative, associated with cursing. Regardless of its linguistic use or emotional valence, cursing is associated with elevated levels of autonomic arousal. That is, we tend to curse when we are in a heightened state of excitement. Cursing tends to modulate physiological arousal both within the speaker, as well as in her interlocutors (Bowers & Pleydell-Pearce, 2011; Jay & Janschewitz, 2008; LaBar & Phelps, 1998). In the sections to follow, I briefly define arousal and describe existing evidence supporting the role of arousal in cursing.

Physiological Arousal

Much of our capacity for exploring and exploiting our environment is mediated by arousal (Aston-Jones & Cohen, 2005). People experience slow fluctuations in arousal in tandem with normal circadian rhythms throughout the day. These oscillations are considered a form of tonic arousal reflecting slowly rising and falling levels of norepinephrine (Posner, 2008; Sturm & Willmes, 2001). Although changes in tonic arousal are typically slow, tonic arousal can build in response to intrinsic and extrinsic stimuli such as slowly building frustration, sustained mental effort, or environmental perturbations. Thus, *tonic arousal* is not synonymous with *low arousal*. Moderately high levels of tonic arousal are seen when people are in states of focused attention, and this state is associated with synergistic phasic activity (Howells et al., 2012).

Phasic arousal, in contrast, is characterized by sudden spikes in autonomic arousal evoked by a new, typically transient state (e.g., sudden fear, pain; (Cannon, 1915; Goldinger & Papesh, 2012). Phasic arousal is a key component of the sympathetic nervous system's 'fight or flight' response, associated with the rapid release of norepinephrine from the locus coeruleus (Ross & Van Bockstaele, 2021).

Tonic and phasic arousal are both associated with physiological changes, including increased heart rate, blood pressure, pupil dilation, sweating, and respiratory rate, and decreased gastrointestinal activity (Alshak & Das, 2023; Pfaff, 2005). In addition to these somatic effects, arousal is also associated with cognitive changes, including rapidly increased alertness, alterations in information processing, and selective attention and memory (Aston-Jones & Cohen, 2005; Staal, 2004).

While moderately increased levels of arousal aid cognitive processes, states of hyperarousal can lead to deficits in cognition and behavior. These include tunnel vision, selective memory, poor decision making, and impaired performance on cognitive tasks (Ross & Van Bockstaele, 2021; Staal, 2004). Yerkes and Dodson described this phenomenon as an inverted U-shaped curve where up to an inflection point, increasing levels of arousal improve cognitive performance, but after the inflection point, further arousal produces rapidly diminishing gains (1908). This is true both in neurotypical people (e.g., the "weapon focus" phenomenon (Loftus et al., 1987); attentional tunneling in open-water divers (Baddeley, 1972)) as well as in those with disorders of hyperarousal. People with post-traumatic stress disorder (PTSD) and traumatic brain injury both demonstrate behaviors consistent with hyperarousal and related phenomena such as hypervigilance, including impulsive behavior, risk-taking, and verbal/physical aggression (Baguley et al., 2006; Kelly & Parry, 2008; Miles et al., 2021). In both neurotypical and disordered populations, a common reaction to highly arousing stimuli (both noxious and pleasant) is to curse.

Cursing and arousal

Cursing tends to evoke somatic markers of autonomic arousal including pupil dilation (Reilly, Zuckerman, et al., 2020), heart rate acceleration (LaPointe, 2006), and increased electrodermal activity (Bowers & Pleydell-Pearce, 2011; Jay & Janschewitz, 2008). Bowers & Pleydell-Pearce investigated arousal as measured by electrodermal activity while participants read aloud curse words, euphemisms that directly referenced the intended curse word (e.g., *F-word*), and neutral words. Arousal was significantly

higher in the cursing condition as compared to the euphemism or neutral conditions, suggesting that it is the phonological form of curse words, rather than an inherently arousing underlying semantic referent, that elicits the arousal response (2011). Compare, for example, the social-pragmatic difference between “piss” and “urine,” which refer to the same substance, or “fuck” and “copulate,” which refer to the same activity.

Across species, arousal responses are thought to help organisms adapt to changes or challenges in their environment. Cursing can convey such advantages by increasing arousal levels. In a cold-pressor paradigm, participants who cursed were able to keep their hands in an ice bath for ~50% longer than participants who were instructed to say a non-curse word (Stephens & Umland, 2011). Cursing led to increases in grip strength and physical power on an exercise bike when compared to repeating non-curse words (Stephens et al., 2018). These findings were explained by increased arousal, perhaps mediated by state disinhibition (Stephens et al., 2023). In addition to physical advantages, cursing can convey emotional and psychological advantages. In a study on cursing and driving, Popuşoi and colleagues found that cursing in simulated stressful driving situations (e.g., avoiding a pedestrian walking out into the street in front of you) led to reduced self-reported affective valence (i.e., less self-reported anger, sadness, or depression) and decreased physical activation (i.e., lower ratings of tension, excitement, anxiety, and nervousness) (Popuşoi et al., 2018). Finally, in a study that bridged both emotional and physical effects, Philipp & Lombardo found that participants who cursed reported less physical pain in a cold pressor task and less social pain after being asked to describe a time when they felt rejected or excluded (2017)

Some have reasoned that the link between arousal and cursing arises from aversive classical conditioning in childhood – when a child swears, they are often punished (e.g., by having their mouth washed out with soap). Through simple paired associate learning, toddlers link cursing with pain (Harris et al., 2003; Jay et al., 2006) either through positive reinforcement (e.g., giving a spanking) or negative reinforcement (e.g., withdrawing affection). Even in households where cursing is not explicitly punished, the emotional and behavioral context in which curse words are uttered may be enough to cause a conditioned response through paired association. When a child sees, e.g., a glass break and hears their mother say, "Fuck," the child learns to associate a word with an arousing antecedent (Jay, 2003). Studies of bilingual speakers support the assertion that the cursing-arousal association is learned early in life; cursing in L1 results in higher physiological arousal and more emotional impact than cursing in L2 (Caldwell-Harris, 2015; Harris et al., 2003).

Cursing and cognition

Several studies have investigated the relationship between tabooness and the memorability of single words. LaBar and Phelps (1998) found that neurotypical adults had superior recall for taboo words relative to non-taboo words. Among participants who had undergone resection of medial temporal lobe structures, including the amygdala and hippocampus, recall for taboo words was worse than recall for non-taboo words, suggesting that taboo words may undergo additional processing via input and emotional coloring from the amygdala (La Bar & Phelps, 1998).

To disentangle whether memorability effects for curse words are driven by arousal or by emotional valence, Kensinger and Corkin compared recognition and memorability of curse words, negatively valent non-taboo words, and neutral words. Curse words, which are highly arousing but only moderately valent, were more memorable than negative or neutral words, suggesting that the memorability of curse words was driven by arousal rather than valence (Kensinger & Corkin, 2003).

It is unclear how recall for single curse words generalizes to recall at the sentence or paragraph level. An additive relationship between the arousal induced by a difficult cognitive task plus the arousal induced by reading curse words could tip a person into a state of hyperarousal, causing a detriment in performance on a recall task. Conversely, curse words may confer memorability to the entire sentence in which they are embedded.

Cursing and Neurological Disorders

Neurogenic cursing is seen in a variety of neurological disorders, including epilepsy, Alzheimer's disease, behavioral variant frontotemporal dementia, traumatic brain injury, Giles de la Tourette syndrome, and stroke aphasia, among others (Van Lancker & Cummings, 1999). It is challenging to disentangle the roles of language, arousal, and inhibitory control in the more diffuse disorders (e.g., epilepsy, Alzheimer's disease). However, some of the more focal disorders that affect one or two facets of cursing lend support for a relationship between arousal and cursing; I describe these below.

Cursing in stroke aphasia tends to be associated with left hemisphere damage (Broca, 1863; Hughlings-Jackson, 1878). When left-hemisphere perisylvian language regions are damaged, aphasia commonly results. One of the hallmarks of aphasia is an impairment in producing propositional language with relative preservation of automatic or overlearned words and phrases (Hughlings-Jackson, 1878; Van Lancker & Cummings, 1999). It is thought that this type of formulaic, non-propositional language is lateralized to the right prefrontal cortex. Thus, a person with profound global aphasia who is unable to produce a single word when cued would often retain the ability to reflexively curse (Van Lancker & Cummings, 1999).

In addition to hemispheric differences in the lateralization of language, left hemisphere damage is also associated with increased arousal, agitation, and depressive symptoms (Gainotti, 1972; Gibson et al., 2022; Mitchell et al., 2017). In contrast, right hemisphere damage is typically associated with *hypo*arousal, apathy, anosagnosia, and a pervasive indifference reaction (Heilman & Van Den Abell, 1980; Hillis, 2006). People with right hemisphere damage tend to curse less than before their brain injury, providing *in vivo* evidence for a double dissociation in the lateralization of cursing (Gainotti, 1972).

In contrast with the left-right lateralization of cursing behaviors and arousal patterns in aphasia, cursing in traumatic brain injury (TBI) is generally associated with disorders of executive function, as exemplified by the constellation of behavioral changes Phineas Gage developed after injury to his left orbitofrontal cortex (Harlow, 1848). Prior to his injury, Gage was described as “temperate of character,” but after his injury he underwent dramatic personality changes, becoming “fitful, irreverent, indulging in times

in the grossest profanity (which was not previously his custom)" (Harlow, 1868, p. 277). The behavioral changes Harlow describes, including increased cursing, align with what today we would call dysexecutive syndrome (Hanna-Pladdy, 2007). Cursing in TBI can occur for two distinct reasons: hyperarousal (stimuli that would not be triggering to a neurotypical person are intensely agitating to a person with TBI) and lack of impulse control, or failure to inhibit the urge to curse in inappropriate contexts.

In the section to follow, I describe a feedback model of cursing and physiological arousal that can be used to understand the patterns of neurogenic cursing described above.

A Model of Cursing and Arousal

I propose the following feedback control mechanism between cursing and physiological arousal: Cursing occurs in the context of arousal. The act of cursing further modulates arousal.

The box and arrow model shown in Figure 1 reflects this relationship.

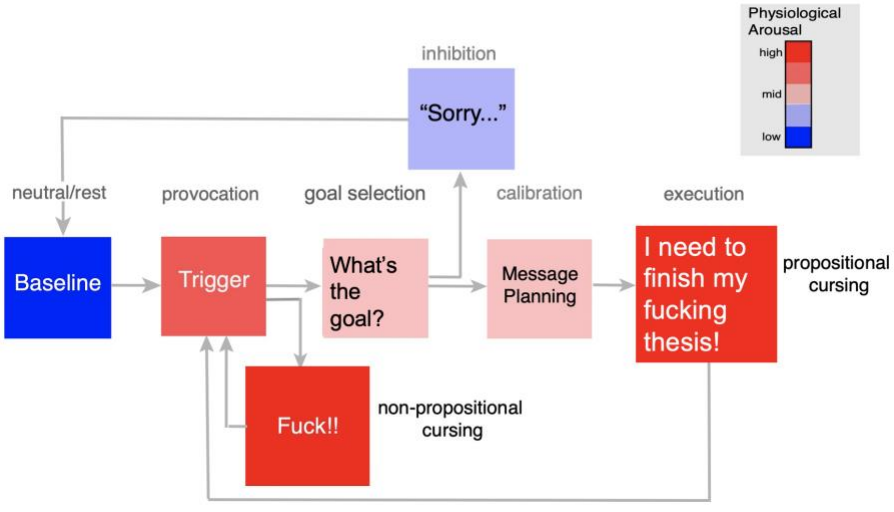

Figure 1. Arousal-cursing feedback model.

Figure 1 illustrates a sequential model progressing from baseline (e.g., calm, low arousal) to one of three possible outcomes when a person encounters a stimulus. That person can either curse non-propositionally, calibrate their cursing to embed it within an utterance (propositionally), or exit the loop and return to baseline lower levels of arousal. I describe each of these stages below.

At baseline, arousal levels are relatively low. People are not anticipating an imminent threat or engaging in a challenging task. In the second stage of the model, a person experiences provocation, or trigger. Triggers can be intrinsic (e.g., frustration at being unable to solve a puzzle) or extrinsic (e.g., an aggressive dog lunges at you). For neurotypical people, a trigger may need to be large or persistent to cause a reaction; for people with disorders of arousal or emotion regulation, even minor inconveniences can be enough to trigger cursing. When a trigger occurs, there are three possible outcomes. The first is related to a rapid spike in phasic arousal that outpaces the inhibitory capacity of cognitive control. When a person experiences intense and sudden pain, fear, anger, pleasure, or excitement, arousal levels spike and the person curses. This form of cursing tends to be non-propositional, taking the form of an interjection or expletive (e.g., "Motherfucker!" when you hit your thumb with a hammer).

The second possible outcome tends to occur when arousal levels rise more slowly, providing time for the person to engage in goal selection and identify, implicitly or explicitly, how to proceed. During this goal selection phase, the person decides whether they will curse in response to a trigger. If they commit to cursing, they calibrate the message to the offense and the offender, and then produce a curse word, usually embedded in the context of a word or phrase (i.e., propositional cursing). The act of

cursing may be cathartic, causing arousal levels to return to baseline. Conversely, for certain people or in certain situations, the act of cursing may increase arousal, thereby acting as a trigger for the next iteration of the cycle.

The third possible outcome after a trigger is that the person opts not to curse. In this case, goal selection does not support cursing, and the person suppresses the urge to curse, perhaps to avoid a confrontation or a social faux pas. After this, the person exits the feedback loop and gradually returns to baseline levels of arousal.

Aims of Current Study

Converging evidence from neuropsychological disorders and behavioral experiments suggests a relationship between cursing and arousal. I posit a feedback control model wherein cursing occurs in the context of arousal and the act of cursing further modulates arousal. In Experiment 1, I compare the lexical environments of curse words to those of randomly selected non-curse words in a large natural language corpus. I hypothesize that cursing occurs in the context of arousal, i.e., that curse words occur in more highly arousing language environments than non-curse words. In Experiment 2, I use a verbal fluency task to investigate how cursing impacts both physiological arousal, as indexed by heart rate, and subsequent language production. I hypothesize that cursing leads to increased heart rate, that words produced in a verbal fluency task immediately after cursing are more arousing than those produced after non-curse words, and that arousal produces interference effects in language production after cursing as measured by number of words produced and latency between stimulus onset and first word production.

CHAPTER 2. METHODS

Experiment 1 Methods: Cursing and Arousal in Natural Language

To investigate the first piece of the arousal-cursing feedback model, that cursing occurs in the context of arousal, I explored the language environments around curse words in a large natural language corpus. The Spotify Podcast Dataset is an open-source database of >600 million words of transcribed English-language podcasts (Clifton et al., 2020). Podcast episodes were sampled from both professional and amateur podcasters, spanned a wide range of topics, and varied in their level of scripting and number of speakers (i.e., monologue vs. one-on-one interview vs. panel discussion). Transcripts were cleaned and lemmatized using a text cleaning algorithm; details can be found in Table 1 (Reilly et al., 2023).

Table 1. Text stripping, vectorizing, and global formatting

Target	Description of Global Action (substitution or omission)
Contractions	Replaced/extended contractions (e.g., it's → it is).
Letter case	All text converted to lowercase.
Stopwords	Omitted closed class words (e.g., the, a, is) using a custom stopword list (N=1,104 words) modified from the SMART (System for the Mechanical Analysis and Retrieval of Text) stopword list.
Non-alphabetic characters	Omitted all punctuation, symbols, emojis, whitespace, and other non-alphabetic characters.
Numbers	Omitted all cardinal and ordinal numbers.
Morphological Derivatives	Lemmatized the text to transform all words into their corresponding dictionary entries.

The resulting database consisted of content words in the order in which they appeared in the podcast (e.g., Tolstoy's "All happy families are alike, but every unhappy family is unhappy in its own way" would become "happy family alike unhappy family unhappy way"). I used an R script to isolate each instance in the database of the ten most frequently occurring English language curse words (*fuck, shit, bitch, cunt, damn/dammit, asshole, dick, ass, pussy, cock*; Rosenberg et al., 2017) as well as the fifteen words occurring immediately before and after each curse word. As a control, I identified an equivalent number of randomly selected non-curse words and their immediate neighbors. I yoked the arousal ratings from the National Research Council Valence, Arousal, and Dominance lexicon (NRC-VAD, Mohammad, 2018) to each neighbor word to compare arousal between curse and control word lexical neighborhoods.

Analyses

I used a multilevel linear mixed effects model (MLM) to analyze the arousal environments of curse and non-curse words, with fixed effects of condition (curse vs. non-curse) and location (words occurring before vs. after the target word), and a random intercept of specific target word (e.g., shit vs. asshole, purpose vs. photo). The MLM was: arousal ~ cond*location +(1|keyword) and R libraries were lme4 and lmerTest (Bates et al., 2015; Kuznetsova et al., 2017).

Experiment 2 Methods: Cursing Verbal Fluency

To examine how cursing affects physiological arousal and subsequent language production, I designed a verbal fluency task examining how arousal and subsequent word production change after participants curse. Participants were cued to name items from various categories. In one task block, one of the categories was curse words, and in the other block, a neutral control category occurred in an analogous position. I measured participants' heart rate throughout the tasks, and compared heart rate, word arousal, total number of words produced, and latency from stimulus onset to first response across cursing and neutral conditions.

Participants

Ten participants were recruited through email from the Temple University community. Inclusion criteria were age 18-35 years, with no neurological disorders, English as a first language, and no reading or visual disabilities by self-report.

Verbal Fluency Procedure and Stimulus Characteristics

Prior to the experiment, participants were familiarized with the experimental structure and given instructions on how to complete a verbal fluency task. Specifically, participants were told that they would hear the name of a category and they should name as many members of the category as possible without repeating any items. They were told they would hear a new category name without warning and should switch to naming members of the new category as soon as possible. Participants were not warned that one of the categories would be curse words, though they were told during the informed consent process that the study involved producing curse words and were given the chance

to opt out of study participation if they did not feel comfortable cursing in the lab setting. Figure 2 shows the trial order for each block (curse vs. neutral).

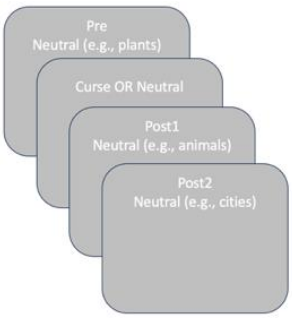

Figure 2. Trial order for cursing verbal fluency task.

Each block was organized in a fixed pseudo-random order with the same internal task structure: neutral (Pre), prime (i.e., curse vs. neutral), neutral (Post1), neutral (Post2). The neutral conditions consisted of low- to moderate-arousal categories (e.g., foods, plants, tools). Prime categories consisted of curse words or a neutral control category (furniture). Within each block type, categories were randomly sampled without replacement such that each category was used once across the experiment. Participants' responses were audio recorded and transcribed; following transcription, I yoked each word produced during the verbal fluency task to its arousal value from the NRC-VAD database (Mohammad, 2018). I measured the latency between presentation of the new category and the production of the first word, as well as total number of words produced per category as a proxy for inter-word latencies (Amunts et al., 2021; Wolters et al., 2016).

Heart rate. Participant heart rate was monitored throughout the experiment using a BIOPAC MP-150 with sampling rate of 1000 Hz. BIOPAC was programmed for normal respiration, with the 35 Hz low pass notch on and the high pass set to 0.5 Hz. I used a three-electrode (bipolar lead) montage when measuring heart rate. One electrode was placed on the inside of the right wrist (VIN-), and the other two electrodes were placed on the insides of each ankle (VIN+ on left ankle, ground on right ankle).

Analyses

I used two-way repeated measures ANOVAs to analyze the relationship between condition (curse vs. neutral) and time (pre-, prime, post1, post2) for arousal, latency between category stimulus presentation and first response, total number of words produced within each category, and average heart rate within each task.

CHAPTER 3. RESULTS

Experiment 1

The R script identified a total of 1988 curse words along with their 59,535 neighbors, and 2000 non-curse words and their 61,239 neighbors in the Spotify Podcast Database. There was a main effect of condition, such that the lexical neighborhoods of curse words were significantly more arousing than those of control words ($p<.0001$). There was no effect of location and the interaction between condition and location was not significant. The results of the MLM are shown in Table 2.

Table 2: Multilevel linear mixed effects model

Fixed effects	Estimate	df	t-value	Pr(>|t|)
(Intercept)	4.895e-01	2.63	72.39	p<.0001***
Cond (neutral)	-3.564e-02	3.00	-4.94	p=.00027***
Location (pre)	3.523e-03	5868	1.60	p=0.1100
Cond*Location	1.495e-05	5880	0.01	p=0.9960

Experiment 2

Participants

A total of 10 participants (7 female) completed the verbal fluency task. Participants' mean age was 21.2 (range, 19-23, SD=1.55 years).

Arousal

I performed a 2x3 nested repeated-measures ANOVA to determine the effect of condition (curse vs. neutral) over time on arousal. There were no significant effects of condition, time, or their interaction (Table 3). I then ran pairwise comparisons using

paired t-tests to investigate whether there were within-group differences at various time points. Words produced in the two non-curse categories that followed cursing were significantly more arousing than words in the non-curse category produced prior to cursing ($p = 0.026$ for Pre:Post1 and $p = 0.015$ for Pre:Post2; Table 4). Within the neutral category, words produced during the neutral Post1 category were significantly more arousing than words produced in the pre-neutral category ($p = 0.029$; Table 4).

Table 3: ANOVA main effects for arousal

Effect	DFn	DFd	F	p
condition	1	9	0.354	0.658
time	3	27	6.843	0.127
condition:time	3	27	3.919	0.203

Table 4: Pairwise comparisons between time points for arousal by condition

			Curse							Neutral		
Times	n1	n2	t	df	p	p adj	Times	n1	n2	t	df	p	p adj
Post1:Pre1	10	7	3.82	6	0.009	0.026*	Post1: Pre1	10	9	3.37	8	0.01	0.029 *
Post2:Pre	8	7	5.57	4	0.005	0.015*	Post2: Pre	8	9	0.184	6	0.86	1
Post1:Post2	10	8	0.39 9	7	0.702	1	Post1: Post2	10	8	1.17	7	0.27 9	0.837

Latency

I performed a 2x4 nested repeated-measures ANOVA to assess the effect of condition (curse vs. neutral) over time on latency between category presentation and production of the first word within each category. P-values were adjusted using the Bonferroni multiple testing correction method There were no significant effects of condition, time, or their interaction. (Table 5).

Table 5: ANOVA main effects for latency

Effect	DFn	DFd	F	p
condition	1	8	1.020	0.342
time	1.24	9.89	1.832	0.209
condition:time	1.24	9.95	3.737	0.076

Total Words

I performed a 2x4 nested repeated-measures ANOVA to evaluate the effect of condition (curse vs. neutral) over time on the number of words produced in each category. P-values were adjusted using the Bonferroni multiple testing correction method. There were significant effects of condition ($p < 0.05$) and time ($p < 0.05$), but not their interaction ($p = 0.3$, see Table 6) so I ran pairwise comparisons using paired t-tests to investigate between- and within-group differences at each time point. Participants produced significantly fewer words in the final category of the cursing block (P2) compared to the final category of the neutral block ($p < 0.01$, see Table 7). Within the cursing category, participants produced fewer words both while cursing ($p = 0.004$) and in P2 ($p = 0.0008$) as compared to the pre-cursing category (see Table 8).

Table 6: ANOVA main effects for number of words

Effect	DFn	DFd	F	p
condition	1	9	5.209	0.048*
time	3	27	5.791	0.003*
condition:time	3	27	1.275	0.303

Table 7: Pairwise comparison between conditions at each time point for number of words

Time	Curse Mean(SD) (n=10)	Neutral Mean(SD) (n=10)	t	df	p	p adj
Pre	10.7(2.75)	11.6(5.08)	-0.585	9	0.573	0.573
During	6.5(1.9)	8.2(2.90)	-1.82	9	0.101	0.101
P1	9.1(3.25)	9.7(5.46)	-0.345	9	0.738	0.738
P2	6.6(3.06)	10.5(4.72)	-3.31	9	0.009	0.009 **

Table 8: Pairwise comparisons between time points for number of words by condition

	Curse						Neutral					
Times	n1	n2	t	df	p	p adj	n1	n2	t	df	p	p adj
During:P1	10	10	-2.33	9	0.045	0.27	10	10	-1.12	9	0.29	1
During:P2	10	10	-0.110	9	0.915	1	10	10	-1.57	9	0.152	0.912
During:Pre	10	10	-5.00	9	0.000743	0.004**	10	10	-2.89	9	0.018	0.107
P1:P2	10	10	1.96	9	0.082	0.49	10	10	-0.569	9	0.583	1
P1:Pre	10	10	-1.25	9	0.241	1	10	10	-1.16	9	0.277	1
P2:Pre	10	10	-6.40	9	0.000125	0.00075***	10	10	-0.514	9	0.62	1

Heart Rate

I performed a 2x4 nested repeated-measures ANOVA to assess the effect of condition (curse vs. neutral) over time on average heart rate within each category. P-values were adjusted using the Bonferroni multiple testing correction method. There were no significant effects of condition, time, or their interaction on heart rate (Table 9).

Table 9: ANOVA main effects for heart rate

Effect	DFn	DFd	F	p
condition	1	9	0.459	0.515
time	3	27	0.653	0.588
condition:time	3	27	1.638	0.204

CHAPTER 4. DISCUSSION

Experiment 1

In this experiment, I examined curse words in context in a large natural language corpus. In line with my predictions, curse words occurred in significantly more arousing environments than did non-curse words. This supports the feedback model in which cursing occurs in the context of arousal. Furthermore, arousal before and after curse words was not significantly different, which supports the idea that cursing can modulate arousal and act as its own arousing trigger, keeping arousal levels high after cursing occurs. That is, in this study, cursing did not appear to have a cathartic effect, at least within fifteen words of the curse word being uttered.

Limitations and Future Directions

The Spotify Podcast Dataset is a large, freely available corpus of spoken language, but because podcasts are often scripted and usually edited, it may not accurately represent cursing behaviors in everyday language. For example, due to editing, curse words may be underrepresented in the corpus, particularly non-propositional curse words (e.g., a podcaster exclaims "Fuck!" after mis-speaking and realizing she needs to do another take). Additionally, because I limited identification of curse words to the ten most frequently occurring English-language curse words, less frequent curse words or those that were inflected in some way (e.g., *cock* was identified, but *cocksucker* would be ignored), are missing from the analyses. Similarly, I excluded slurs from my list of curse words. As identity-based slurs are coming to replace curse words as the truly taboo words in our language, exclusion of slurs from these analyses may underestimate the arousal

effects of highly taboo words (McWhorter, 2021). Expanding the search list to include inflections as well as less common curse words and slurs is an area for future analysis.

Because conversational boundaries are not marked in the Spotify corpus, it is unknown whether arousal effects may be due in part to activation of a conversation partner who is exposed to the initial curse word. Consider the following (imagined) exchange from a podcast:

Speaker 1: Hey, man, watch your mouth! Fuck off!

Speaker 2: Could you please stop yelling (arousal = 0.939)? You're frightening (arousal = 0.969) me.

Speaker 1: I'm sorry (arousal = 0.362).

In the analyses for Experiment 1, the highly arousing words *yelling* and *frightening* would occur within the fifteen-word window of *fuck*, even though they were not uttered by the same speaker. Future work using a corpus of transcribed conversations with speaker information preserved, such as the CANDOR corpus, would permit disambiguation of arousal effects of cursing both within and across speakers (Reece et al., 2023).

Finally, results from the cursing verbal fluency experiment described below suggest that there may be delayed effects of cursing on language production, so widening the neighborhood around curse and control words in subsequent analyses may uncover differences in pre- vs. post-curse word environments to help elucidate how cursing modulates arousal over longer periods of time.

Experiment 2

In this experiment, I examined the effects of cursing on arousal and subsequent language production in a cursing verbal fluency task. As in Experiment 1, there were significant effects of cursing on arousal. Words produced immediately after cursing and neutral blocks were more arousing than those produced before (P1 > Pre for both curse and neutral conditions). However, in line with my predictions, in the cursing condition but not the neutral condition this effect persisted into the final category of the block (P2 > Pre for cure but not neutral). This supports the idea that cursing modulates arousal, since words in the cursing condition remained more arousing up to forty seconds after participants stopped cursing. Contrary to my predictions, there were no significant differences in average heart rate or latency between stimulus onset and production of first word.

In addition to lingering effects of arousal, there was a significant reduction in total number of words produced in the final category of the cursing block compared to both the number of words in the pre-curse category and the number of words in the analogous neutral block. Number of words produced in a verbal fluency task is correlated with lexical retrieval and executive functioning, raising the question of whether cursing might be acting to interfere with these processes (Amunts et al., 2021). If that were the case, there could be important implications for treatment of patients with both neurogenic cursing and impairments in lexical retrieval and executive function: if cursing interferes with lexical retrieval, reducing neurogenic cursing might improve word retrieval.

The study design involved repeated task-switching, which can place demands on executive function (Amunts et al., 2021). There were no effects of condition on latency to

first word production, indicating that cursing and arousal did not significantly interfere with participants' ability to task switch. When taken with the number of word results, we see an interesting dissociation where one type of executive function task (task-switching) is not affected but another (lexical retrieval) is.

Limitations and Future Directions

All analyses are limited by the small sample size; data collection is ongoing. Additionally, there is missingness in the arousal analyses, as two of the neutral categories (countries, cities) are proper nouns and do not have arousal values in the VAD database.

None of the heart rate analyses reached significance, which could be caused by small sample size, noise in the heart rate date (e.g., from participant movement or poor electrode contact), or a combination of both factors. Additionally, heart rate in the first category of each block jumped an average of 5-7 beats per minute from washout, so heart rate responses to cursing-induced arousal may be obscured by overall physiological responses to the task demands.

Another limitation of this study is that cursing in a verbal fluency task is non-propositional and bears little resemblance to how people typically curse. Future studies would benefit from a more naturalistic design, such as providing participants with a role-play scenario in which they might be expected to curse (e.g., a stressful driving experience or highly exciting event) and comparing subsequent language production and physiological responses to those induced by a neutral prompt (e.g., going for a walk in the park and admiring the scenery).

General Discussion

These two studies support the idea that cursing occurs in the context of arousal and has a modulatory effect on arousal, but the precise degree and duration of this relationship remains unclear. Common sense and experience tell us that cursing is not a perpetual motion machine that powers itself by keeping us aroused forever, but further work to investigate the latter parts of this feedback mechanism are needed. In addition, further study is needed to refine the predictions the model makes about propositional and non-propositional cursing and where cursing-induced catharsis fits.

Experiment 2 was conducted with neurotypical young adult participants; demographic information on speakers in Experiment 1 is not available but it seems safe to assume that most speakers were neurotypical, or at least did not experience neurogenic cursing. Future studies involving participants with neurogenic cursing are needed to understand how the body reacts during and after neurogenic cursing as compared to typical propositional and non-propositional cursing.

Arousal and emotion dysregulation offer potential treatment targets for people who experience uncontrolled cursing, including biofeedback, emotion regulation strategies, and non-invasive brain stimulation (e.g. right hemisphere tDCS). Additionally, the finding from Experiment 2 suggesting cursing may impede lexical retrieval opens potential treatment targets for neurogenic cursing and anomia.

Cursing is a behavior with wide individual and cultural variability. This study focused on native speakers of American English, but no information on their personal cursing habits or attitudes toward cursing (e.g., religiosity) was collected. Because bilinguals exhibit different arousal responses to cursing in L1 vs L2, an experiment in

bilingual populations could help untangle whether the cognitive effects of cursing are due to attentional capture vs. arousal (Caldwell-Harris, 2015).

CHAPTER 5. CONCLUSION

A natural language and behavioral experiment support the role of arousal in and around cursing. A general finding is that cursing occurs in the context of arousal and further modulates arousal as well as subsequent language production, possibly by interfering with lexical retrieval. These studies contribute to the body of literature investigating how curse words and other taboo words affect arousal, behavior, cognition, and language. Further work is necessary to untangle the relationship and to identify potential treatment targets for people affected by neurogenic cursing.

REFERENCES

Alshak, M. N., & M Das, J. (2023). Neuroanatomy, Sympathetic Nervous System. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK542195/

Alvarez, J. A., & Emory, E. (2006). Executive function and the frontal lobes: A meta-analytic review. *Neuropsychology Review*, *16*(1), 17–42. https://doi.org/10.1007/s11065-006-9002-x

American Film Institute. (n.d.). *AFI's 100 Years...100 movie quotes.* Retrieved November 8, 2023, from https://www.afi.com/afis-100-years-100-movie-quotes/

Amunts, J., Camilleri, J. A., Eickhoff, S. B., Patil, K. R., Heim, S., von Polier, G. G., & Weis, S. (2021). Comprehensive verbal fluency features predict executive function performance. *Scientific Reports*, *11*, 6929. https://doi.org/10.1038/s41598-021-85981-1

Aston-Jones, G., & Cohen, J. D. (2005). AN INTEGRATIVE THEORY OF LOCUS COERULEUS-NOREPINEPHRINE FUNCTION: Adaptive Gain and Optimal Performance. *Annual Review of Neuroscience*, *28*(1), 403–450. https://doi.org/10.1146/annurev.neuro.28.061604.135709

Baddeley, A. D. (1972). Selective attention and performance in dangerous environments. *British Journal of Psychology*, *63*(4), 537–546. https://doi.org/10.1111/j.2044-8295.1972.tb01304.x

Baguley, I. J., Cooper, J., & Felmingham, K. (2006). Aggressive behavior following traumatic brain injury: How common is common? *The Journal of Head Trauma Rehabilitation*, *21*(1), 45–56. https://doi.org/10.1097/00001199-200601000-00005

Baruch, Y., & Jenkins, S. (2007). Swearing at work and permissive leadership culture: When anti-social becomes social and incivility is acceptable. *Leadership & Organization Development Journal*, *28*(6), 492–507. https://doi.org/10.1108/01437730710780958

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*, 1–48. https://doi.org/10.18637/jss.v067.i01

Bowers, J. S., & Pleydell-Pearce, C. W. (2011). Swearing, Euphemisms, and Linguistic Relativity. *PLoS ONE*, *6*(7), e22341. https://doi.org/10.1371/journal.pone.0022341

Broca, P. (1863). Localisation des fonctions cérébrales: Siée du langage articulé. *Bulletin of the Society of Anthropology (Paris)*, *4*.

Cain, Sian. (2023, May 23). We invoked Shakespeare': Kates McLennan and McCartney on explaining Australian swearing to Amazon. *The Guardan*. https://www.theguardian.com/tv-and-radio/2023/may/27/we-invoked-shakespeare-kates-mclennan-and-mccartney-on-explaining-australian-swearing-to-amazon

Caldwell-Harris, C. L. (2015). Emotionality differences between a native and foreign language: Implications for everyday life. *Current Directions in Psychological Science*, *24*(3), 214–219. https://doi.org/10.1177/0963721414566268

Cannon, W. B. (1915). *Bodily changes in pain, hunger, fear and rage: An account of recent researches into the function of emotional excitement.* D Appleton & Company.

Clifton, A., Reddy, S., Yu, Y., Pappu, A., Rezapour, R., Bonab, H., Eskevich, M., Jones, G., Karlgren, J., Carterette, B., & Jones, R. (2020). 100,000 Podcasts: A Spoken English Document Corpus. *Proceedings of the 28th International Conference on Computational Linguistics*, 5903–5917. https://doi.org/10.18653/v1/2020.coling-main.519

Eddy, C. M., & Cavanna, A. E. (2013). 'It's a curse!': Coprolalia in Tourette syndrome. *European Journal of Neurology*, *20*(11), 1467–1470. https://doi.org/10.1111/ene.12207

Gainotti, G. (1972). Emotional Behavior and Hemispheric Side of the Lesion. *Cortex, 8*(1), 41–55. https://doi.org/10.1016/S0010-9452(72)80026-1

Gibson, B. C., Vakhtin, A., Clark, V. P., Abbott, C. C., & Quinn, D. K. (2022). Revisiting Hemispheric Asymmetry in Mood Regulation: Implications for rTMS for Major Depressive Disorder. *Brain Sciences, 12*(1), 112. https://doi.org/10.3390/brainsci12010112

Goldinger, S. D., & Papesh, M. H. (2012). Pupil Dilation Reflects the Creation and Retrieval of Memories. *Current Directions in Psychological Science*, *21*(2), 90–95. https://doi.org/10.1177/0963721412436811

Hanna-Pladdy, B. (2007). Dysexecutive Syndromes in Neurologic Disease. *Journal of Neurologic Physical Therapy*, *31*(3), 119. https://doi.org/10.1097/NPT.0b013e31814a63c2

Harlow, J. (1848). Passage of an Iron Rod Through the Head. *Boston Med Surg J, 39*, 389–393.

Harlow, J. (1868). Recovery from the passage of an iron bar through the head. *Publications of the Massachusetts Medical Society*, *2*, 274–281.

Harris, C. L., Ayçiçeği, A., & Gleason, J. B. (2003). Taboo words and reprimands elicit greater autonomic reactivity in a first language than in a second language. *Applied Psycholinguistics*, *24*(4), 561–579. https://doi.org/10.1017/S0142716403000286

Heilman, K. M., & Van Den Abell, T. (1980). Right hemisphere dominance for attention: The mechanism underlying hemispheric asymmetries of inattention (neglect). *Neurology*, *30*(3), 327–330. https://doi.org/10.1212/wnl.30.3.327

Hillis, A. E. (2006). Neurobiology of unilateral spatial neglect. *The Neuroscientist: A Review Journal Bringing Neurobiology, Neurology and Psychiatry*, *12*(2), 153–163. https://doi.org/10.1177/1073858405284257

Howells, F. M., Stein, D. J., & Russell, V. A. (2012). Synergistic tonic and phasic activity of the locus coeruleus norepinephrine (LC-NE) arousal system is required for optimal attentional performance. *Metabolic Brain Disease*, *27*(3), 267–274. https://doi.org/10.1007/s11011-012-9287-9

Hughlings-Jackson, J. (1878). On Affectations of Speech from Disease of the Brain. *Brain*, *1*(3), 304–330. https://doi.org/10.1093/brain/1.3.304

Janschewitz, K. (2008). Taboo, emotionally valenced, and emotionally neutral word norms. *Behavior Research Methods*, *40*(4), 1065–1074. https://doi.org/10.3758/BRM.40.4.1065

Jay, T. (2000). *Why We Curse: A Neuro-Psycho-Social Theory of Speech*. John Benjamins Publishing Company.

Jay, T. (2003). *Cursing in America: A Psycholinguistic Study of Dirty Language in the Courts, in the Movies, in the Schoolyards, and on the Streets*. John Benjamins Publishing Company.

Jay, T., & Janschewitz, K. (2008). The pragmatics of swearing. *Journal of Politeness Research. Language, Behaviour, Culture*, *4*(2). https://doi.org/10.1515/JPLR.2008.013

Jay, T., King, K., & Duncan, T. (2006). Memories of Punishment for Cursing. *Sex Roles*, *55*(1–2), 123–133. https://doi.org/10.1007/s11199-006-9064-5

Jonason, P. K., Betteridge, G. L., & Kneebone, I. I. (2016). An Examination of the Nature of Erotic Talk. *Archives of Sexual Behavior*, *45*(1), 21–31. https://doi.org/10.1007/s10508-015-0585-2

Kelly, G., & Parry, A. (2008). Managing Challenging Behaviour of People With Acquired Brain Injury in Community Settings: The First 7 Years of a Specialist Clinical Service. *Brain Impairment*, *9*(3), 293–304. https://doi.org/10.1375/brim.9.3.293

Kensinger, E. A., & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory & Cognition*, *31*(8), 1169–1180. https://doi.org/10.3758/bf03195800

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, *82*, 1–26. https://doi.org/10.18637/jss.v082.i13

LaBar, K. S., & Phelps, E. A. (1998). Arousal-mediated memory consolidation: Role of the medial temporal lobe in humans. *Psychological Science*, *9*(6), 490–493. https://doi.org/10.1111/1467-9280.00090

LaPointe, L. L. (2006). Profanity. *Journal of Medical Speech - Language Pathology*, *14*(1), vii–vii.

Le Dorze, G., & Brassard, C. (1995). A description of the consequences of aphasia on aphasic persons and their relatives and friends, based on the WHO model of chronic diseases. *Aphasiology*, *9*(3), 239–255. https://doi.org/10.1080/02687039508248198

Loftus, E. F., Loftus, G. R., & Messo, J. (1987). Some facts about "weapon focus." *Law and Human Behavior*, *11*(1), 55–62. https://doi.org/10.1007/BF01044839

McLeod, L. (2011). Swearing in the 'Tradie' Environment as a Tool for Solidarity. *Griffith Working Papers in Pragmatics and Intercultural Communication*, *4*(1/2), 1–10.

McWhorter, J. (2021). *Nine Nasty Words: English in the Gutter—Then, Now, and Forever*. Avery.

Miles, S. R., Hammond, F. M., Neumann, D., Silva, M. A., Tang, X., Kajankova, M., Dillahunt-Aspillaga, C., & Nakase-Richardson, R. (2021). Evolution of Irritability, Anger, and Aggression after Traumatic Brain Injury: Identifying and Predicting Subgroups. *Journal of Neurotrauma*, *38*(13), 1827–1833. https://doi.org/10.1089/neu.2020.7451

Mitchell, A. J., Sheth, B., Gill, J., Yadegarfar, M., Stubbs, B., Yadegarfar, M., & Meader, N. (2017). Prevalence and predictors of post-stroke mood disorders: A meta-analysis and meta-regression of depression, anxiety and adjustment disorder. *General Hospital Psychiatry*, *47*, 48–60. https://doi.org/10.1016/j.genhosppsych.2017.04.001

Mohammad, S. (2018). Obtaining Reliable Human Ratings of Valence, Arousal, and Dominance for 20,000 English Words. *Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers)*, 174–184. https://doi.org/10.18653/v1/P18-1017

Peralta, E. (2011, January 5). Swear Freely In Pennsylvania: It's Your #$%^&*^ Constitutional Right. *NPR*. https://www.npr.org/sections/thetwo-way/2011/01/05/132678940/swear-freely-in-pennsylvania-its-your-constitutional-right

Pfaff, D. (2005). *Brain Arousal and Information Theory: Neural and Genetic Mechanisms*. Harvard University Press.

Philipp, M. C., & Lombardo, L. (2017). Hurt feelings and four letter words: Swearing alleviates the pain of social distress. *European Journal of Social Psychology*, *47*(4), 517–523. https://doi.org/10.1002/ejsp.2264

Popuşoi, S. A., Havârneanu, G. M., & Havârneanu, C. E. (2018). "Get the f#∗k out of my way!" Exploring the cathartic effect of swear words in coping with driving anger. *Transportation Research Part F: Traffic Psychology and Behaviour*, *56*, 215–226. https://doi.org/10.1016/j.trf.2018.04.013

Posner, M. I. (2008). Measuring alertness. *Annals of the New York Academy of Sciences*, *1129*, 193–199. https://doi.org/10.1196/annals.1417.011

Reece, A., Cooney, G., Bull, P., Chung, C., Dawson, B., Fitzpatrick, C., Glazer, T., Knox, D., Liebscher, A., & Marin, S. (2023). The CANDOR corpus: Insights from a large multimodal dataset of naturalistic conversation. *Science Advances*, *9*(13), eadf3197. https://doi.org/10.1126/sciadv.adf3197

Reilly, J., Finley, A. M., Litovsky, C. P., & Kenett, Y. N. (2023). Bigram semantic distance as an index of continuous semantic flow in natural language: Theory, tools, and applications. *Journal of Experimental Psychology: General*, *152*(9), 2578–2590. https://doi.org/10.1037/xge0001389

Reilly, J., Kelly, A., Zuckerman, B. M., Twigg, P. P., Wells, M., Jobson, K. R., & Flurie, M. (2020). Building the perfect curse word: A psycholinguistic investigation of the form and meaning of taboo words. *Psychonomic Bulletin & Review*, *27*(1), 139–148. https://doi.org/10.3758/s13423-019-01685-8

Reilly, J., Zuckerman, B., Kelly, A., Flurie, M., & Rao, S. (2020). Neuromodulation of cursing in American English: A combined tDCS and pupillometry study. *Brain and Language*, *206*, 104791. https://doi.org/10.1016/j.bandl.2020.104791

Robbins, M. L., Focella, E. S., Kasle, S., López, A. M., Weihs, K. L., & Mehl, M. R. (2011). Brief Report: Naturalistically Observed Swearing, Emotional Support and Depressive Symptoms in Women Coping with Illness. *Health Psychology : Official Journal of the Division of Health Psychology, American Psychological Association*, *30*(6), 789–792. https://doi.org/10.1037/a0023431

Ross, J. A., & Van Bockstaele, E. J. (2021). The Locus Coeruleus- Norepinephrine System in Stress and Arousal: Unraveling Historical, Current, and Future

Perspectives. *Frontiers in Psychiatry*, *11*, 601519. https://doi.org/10.3389/fpsyt.2020.601519

Staal, M. A. (2004). Stress, Cognition, and Human Performance: A Literature Review and Conceptual Framework. *Nasa Technical Reports Server*.

Stephens, R. (2018). The psychobiology underlying swearing and taboo language. In *The Routledge International Handbook of Psychobiology*. Routledge.

Stephens, R., Atkins, J., & Kingston, A. (2009). Swearing as a response to pain. *Neuroreport*, *20*(12), 1056–1060. https://doi.org/10.1097/WNR.0b013e32832e64b1

Stephens, R., Dowber, H., Barrie, A., Almeida, S., & Atkins, K. (2023). Effect of swearing on strength: Disinhibition as a potential mediator. *Quarterly Journal of Experimental Psychology*, *76*(2), 305–318. https://doi.org/10.1177/17470218221082657

Stephens, R., Spierer, D. K., & Katehis, E. (2018). Effect of swearing on strength and power performance. *Psychology of Sport and Exercise*, *35*, 111–117. https://doi.org/10.1016/j.psychsport.2017.11.014

Stephens, R., & Umland, C. (2011). Swearing as a response to pain-effect of daily swearing frequency. *The Journal of Pain*, *12*(12), 1274–1281. https://doi.org/10.1016/j.jpain.2011.09.004

Sturm, W., & Willmes, K. (2001). On the functional neuroanatomy of intrinsic and phasic alertness. *NeuroImage*, *14*(1 Pt 2), S76-84. https://doi.org/10.1006/nimg.2001.0839

Van Lancker, D., & Cummings, J. L. (1999). Expletives: Neurolinguistic and neurobehavioral perspectives on swearing. *Brain Research Reviews*, *31*(1), 83–104. https://doi.org/10.1016/S0165-0173(99)00060-0

Vingerhoets, A. J. J. M., Bylsma, L. M., & de Vlam, C. (2013). Swearing: A biopsychosocial perspective. *Psihologijske Teme*, *22*(2), 287–304.

Wolters, M. K., Kim, N., Kim, J.-H., MacPherson, S. E., & Park, J. C. (2016). Prosodic and Linguistic Analysis of Semantic Fluency Data: A Window into Speech Production and Cognition. *Interspeech 2016*, 2085–2089. https://doi.org/10.21437/Interspeech.2016-420

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology*, *18*(5), 459–482. https://doi.org/10.1002/cne.920180503